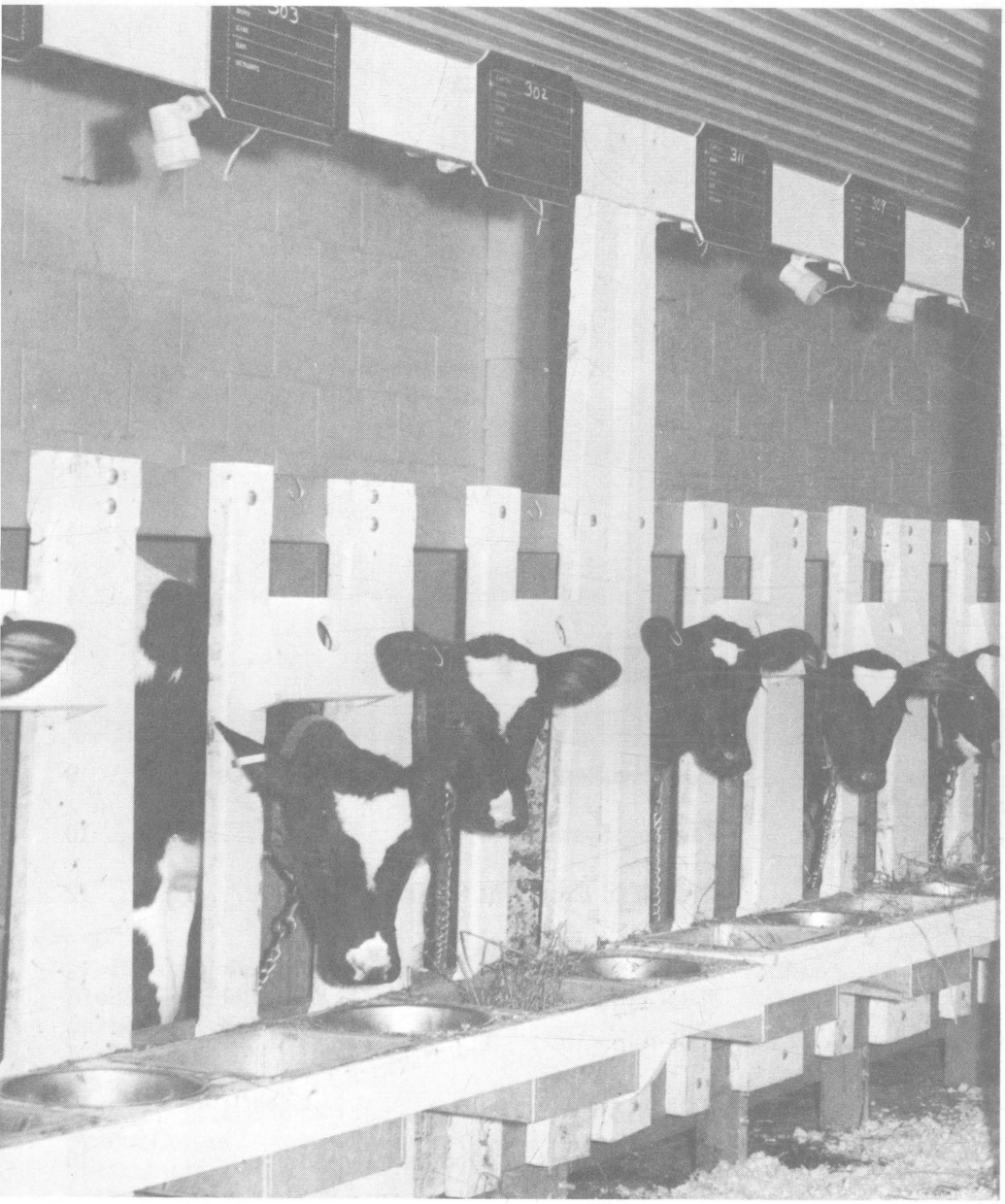
Bulletin 514



RAISING DAIRY HERD REPLACEMENTS

Cooperative Extension Service—The Ohio State University

Raising Dairy Herd Replacements

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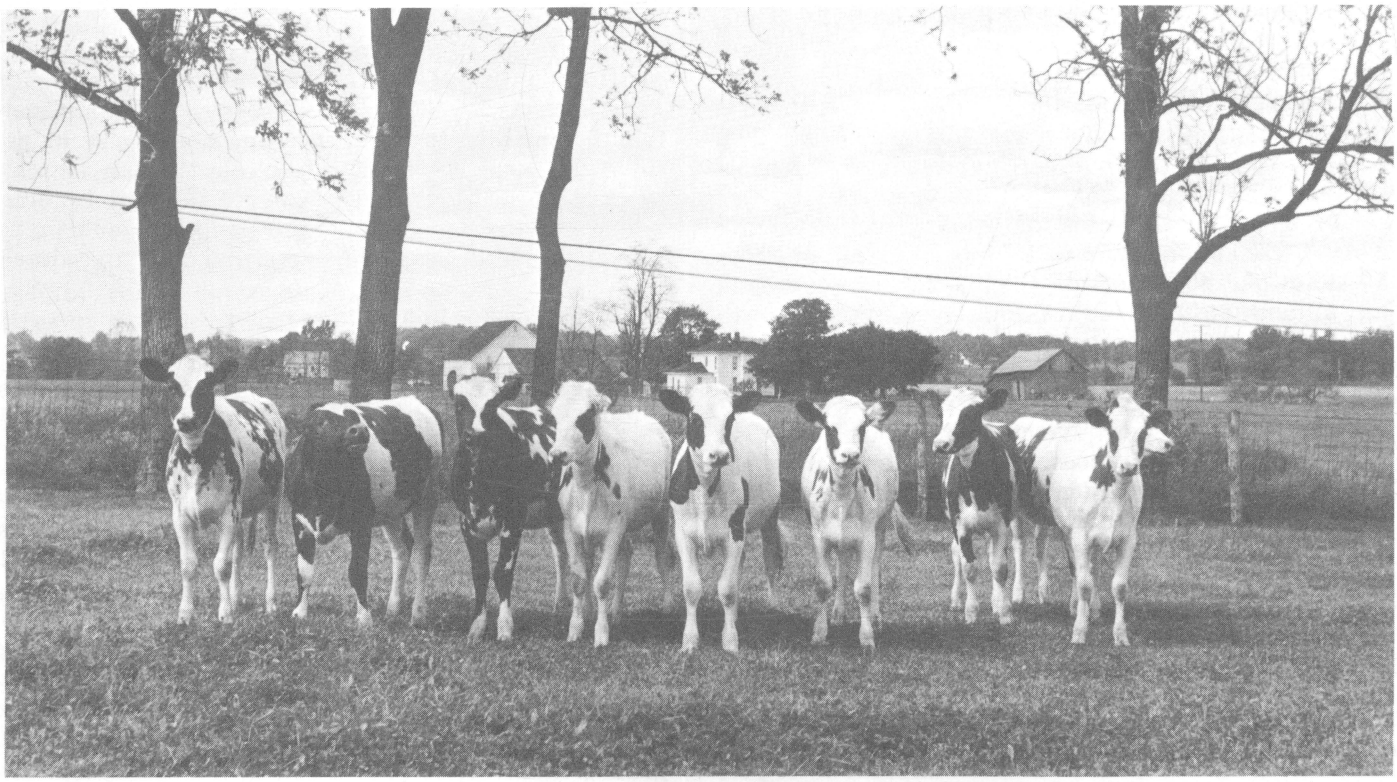


Many dairymen raise all their calves for increased selection of herd replacements

Raising enough replacements with high milk production potential is one of the most important parts of a dairy enterprise. Improvement of any herd is possible only when discarded cows are replaced by well-fed, well-bred and properly managed replacements. One of the best ways to improve herd production is to mate cows to sires of known transmitting ability and feed and manage the resultant heifers in a manner which enables them to express their inherent potential for milk production.

The number of calves dairymen need to raise each year to maintain herd size depends largely on herd management and herd health. Dairy Herd Improvement Association results indicate that 20 to 30 percent of the milking herd must be replaced each year.

Not all calves born will live, develop properly or reproduce well. Calf losses during early life run as high as 30 percent on some farms. Table 1 indicates the number of replacement heifers available under good, average, and poor management when calving intervals are 12 and 15 months. With herd turnover ranging from 20 to 30 percent annually, it is obvious when management is average or less that little, if any, selection of replacement heifers can be made. It then becomes strictly a matter of choosing between the elimination of older cows or a heifer of unknown producing ability.

Table 1: Potential Yearly Calf Crop and Heifer Replacements Per 100 Cows with Cows Calving at Various Intervals Under Various Management Conditions

	12-Month Calving Interval			15-Month Calving Interval		
Potential Calves per 100 cows per year				**100**		
Management conditions	**Predicted Loss** Percent			**Potential Calves**		**80 Remaining After Loss**
	Good	Av.	Poor	Good	Av. Poor	Good	Av. Poor
Loss due to:						
Sterility	3	7	10	97	93 90	77	74 72
Abortion	3	6	11	94	87 79	75	69 63
Stillbirths	3	7	12	91	80 67	72	63 53
Death before 23 months of age	5	12	17	86	68 50	67	53 40
Males	50	50	50	43	34 25	34	27 20
Potential female replacements	..	..	..	43	34 25	33	26 20

Salisbury and VanDemark text on "Physiology of Reproduction and Artificial Insemination of Cattle" W. H. Freeman & Co., San Francisco, 1961

Breeding first calf heifers to beef bulls is a practice followed by some Ohio dairymen. This is an attempt to reduce difficulty at time of calving. However, the size of the dam appears to have a greater influence on calf size than the breed of the sire. Therefore, this does not seem to be good practice. The average dairy cow produces only about 3 calves

in her lifetime, of which 1 to 3 may be bulls. Thus, the loss of a potential replacement markedly reduces the opportunity for selection.

Since Ohio has about 450,000 dairy cows, there is an annual replacement need for nearly 135,000 heifers. To raise this number involves a large investment in feed, time, labor, and equipment.

In general, the cost of raising replacements ranges from about $250 to $350 per animal, or 25 to 30 cents per pound of gain. This, therefore, means an annual cost of approximately $34,000,000 to $47,000,000. An investment of this magnitude deserves serious consideration as to how to obtain the most from it.

The first step is to give calves a good start early in life. Reducing calf losses to near zero can effect considerable savings in many herds. Use of better herd sires, adoption of more economical methods of calf raising, and reducing herd turnover due to disease and injury are other measures which can help keep losses down in individual herds.

Dairy Cattle Breeding and Reproduction

The Pedigree

The Pedigree of an animal is simply a record of its ancestry. It contains the names and registration numbers of the sire, dam, grandsires, and granddams of the animal. To be a useful selection tool, the pedigree should also include all available information on production and type classification for the animal which it represents. When it does, it can be used as an aid in estimating an animal's producing and transmitting ability.

Production records on the animal being selected are more important in predicting future performance than any other information contained in the pedigree.

A pedigree could be thought of as the recommendations an animal might use if it were making application for a job.

In Figure 1 note that 50 percent of an animal's inheritance comes from each of the animal's parents and that, on the average, each of the 4 grandparents contribute 25 percent and each great grandparent provides only 12½ percent of any given animal's genetic make-up. Therefore, the sire and dam contribute entirely to the inheritance and should receive the most emphasis when selecting an animal.

Also from Figure 1 you can see that outstanding animals listed far back in the pedigree could have very little influence on the performance of an animal.

What To Look For In A Pedigree

Information of primary importance in evaluating a pedigree could be listed in order of emphasis as follows:

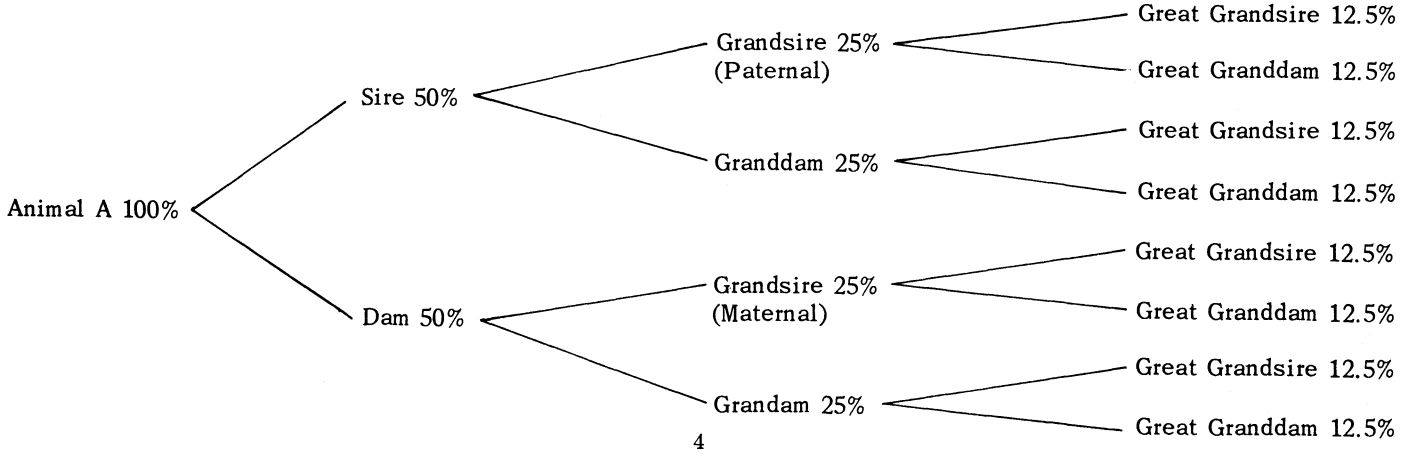
1. Animal's own production records
2. Sire's proof on production
3. Production of the animal's dam
4. Proof on the grandsires and production of the granddams
5. Classification rating (Type Score) on each animal

A sire, of course, does not give milk, but his transmitting ability is shown in the milk and butterfat production of his daughters.

Early in the development of proved sire programs, the **average production of a sire's daughters** made in a single herd was used as an indication of a sire's merit. Study of this method showed that the daughter average was closely related to the production level of the herd in which he was used. For example, daughters of the same sire in 3 Ohio herds had the following milk production averages: 10,846 pounds, 13,804 pounds, and 16,997 pounds, indicating a big difference in the feeding and management in the herds in which he was used.

A decided improvement over this method of sire evaluation came with the development of the **daughter-dam comparison** sire proof. But this, too, contained inaccuracies because most of the dams made their records in years previous to the daughter's production records. This often caused management and feeding changes to be interpreted as genetic superiority or inferiority of the daughters.

Fig. 1: Pedigree form showing average genetic contributions made by each ancestor to animal A.



Further refinement in sire proving came with a more accurate evaluation known as the **herdmate comparison.** This procedure involves comparison of the daughters of a sire with the daughters of all other sires in the same herd freshening in the same season of the year. It was also discovered that information derived from many herd proofs (AI proof) was superior to that obtained from a one-herd proof (natural proof). This improved accuracy results from a better evaluation of genetic levels of sires by getting a cross section of several herds, and removal of possible bias inherent in a natural proof.

Going one step further, the current sire summaries include two additional tools, namely **Predicted Difference** and **Repeatability.** Predicted Difference gives us an estimate of the transmitting ability of a bull. It indicates what future daughters of a sire would be expected to do in relation to herdmates of breed-average ability.

The question arises, how much better is a sire who raises production by 1,000 pounds over 13,000-pound herdmates compared with a sire who raises production by 1,000 pounds over 11,000-pound herdmates? This adjustment can be made since it is known that only 10 percent of the difference between the daughters of a sire is caused by the genetic difference between herds.

The application of this 10 percent genetic difference is made by crediting the bull with an additional 100-pound increase over herdmates for every 1,000 pounds the herdmates exceed the breed average. For example, a sire that raised production at the 14,000-pound level by 200 pounds of milk (breed average 13,000 lbs.) would be expected to raise it by 300 pounds at breed average. Thus, the bull with the highest predicted difference has the highest probability of raising production in any herd.

Repeatability tells us how much faith to put in a bull proof. It is a numerical way of expressing confidence. Repeatability will usually range from 20 to 99 percent. Bulls proved in only 1 or 2 herds will have a low repeatability (20-30%), whereas an AI Proved sire with daughters in many herds may be as high as 99 percent. The more information we have, the more accurate it is and the more confidence we can place in it. A proof with a high repeatability won't normally change much, but one with low repeatability is subject to change upward or downward.

In evaluating a pedigree, items which should receive little or no emphasis include:

1. Animals beyond the grandparents
2. Sale price received for animals
3. Showing winnings

This type of information has little value in estimating the transmitting ability of an animal.

The true genetic ability of an animal is never known, but by using modern breeding tools in selection, we can arrive at a reliable estimate of breeding value.

Genetics

Genetics is the science that deals with the laws of inheritance. Genes are what we inherit from our parents or what the calf inherits from its parents. In the case of man, it is that which determines his mental ability and physical characteristics such as color, size, and shape. Living things are able to reproduce themselves with reasonable accuracy. You have no difficulty distinguishing between a horse and a cow or between a Jersey and a Holstein.

How Life Begins

A calf, like man and other mammals, grows entirely from one cell, a fertilized egg. This cell is formed from the union of 2 minute cells, the sperm from the sire and the egg from the dam. This process is known as fertilization and results in the beginning of a new individual and life. This tiny bit of living material (the fertilized egg) is the only bridge between the offspring and parents. All inherited characteristics are contained in the fertilized egg.

In the center or nucleus of a fertilized cell are rod-shaped structures called chromosomes. Each chromosome contains units of inheritance known as genes. The chromosomes are similar to a string of beads with genes located on each chromosome. The gene is the basic unit of inheritance. Each inherited characteristic, such as hair color, eye color, or milk production is controlled by one or more genes.

The chromosomes always appear in pairs except in the sperm and the egg where only one member of each pair is found. In cattle there are 30 pairs. In the egg of the cow there are 30 individual chromosomes, each slightly different from the other. For each individual chromosome in the egg, there is another chromosome corresponding to it in the sperm of the bull. Thus, when the sperm and egg join to form a new animal, chromosomes become paired to make up the 30 pairs of chromosomes as shown in Figure 2.

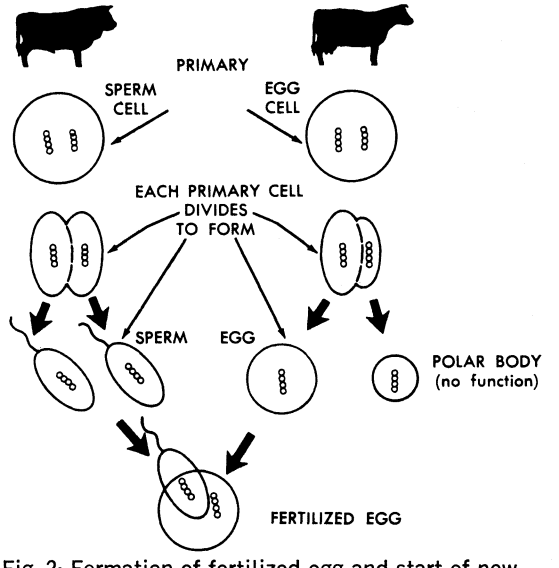


Fig. 2: Formation of fertilized egg and start of new individual. Only 1 pair chromosomes shown. There are 36 pairs in cattle.

This joining of chromosomes enables the genes to become paired also, and one gene pair may determine whether or not the animal has horns, another pair may determine hair coat, and other pairs will influence such things as milk and butterfat production. Only one sperm can fertilize an egg, so one chromosome from each pair is contributed by the sire and one by the dam.

Usually only one egg is formed at a time in the dairy cow, but millions of sperm are produced by the bull. When the primary egg cell divides in the cow, one-half of the chromosomes go to each of the resulting cells. However, most of the other cell material goes to the egg which leaves a small cell called a polar body. The polar body is cast off with no apparent function. At the time of breeding, sperm are deposited in the reproductive tract of the cow and one sperm fertilizes the egg.

Sex Determination

The sex of the new individual is determined by the chromosomes. Of the 30 pairs of chromosomes, there is one pair called the sex chromosomes. These are usually referred to as the X and Y chromosomes. In the male, one chromosome of the sex-determining pair is X and the other chromosome is Y. In the female cell, both chromosomes of the pair are X. When the cells divide, the male cell forms one sperm which carries an X chromosome and another which carries the Y. The female cell forms an egg with an X chromosome only. When the X from the male joins the X from the female, the offspring is female. When the Y from the male joins the X from the female, the offspring is male. Chance alone determines what will happen.

Milk Inheritance

The inheritance for milk production is more complicated. For this example let us assume that 3 gene pairs are involved, although many hundreds of pairs may be involved. The capital letters in Figure 3 stand for 3,000 pounds of milk production and the small letters for 1,500 pounds of milk. If the large A, small b, and large C (AbC) chromosomes from the male join the AbC chromosomes from the female, the new offspring will be AAbbCC and have the the potential to produce 15,000 pounds of milk. However, if the other two chromosomes aBc unite, the individual will have the potential to produce only 12,000 pounds of milk. These are only two of the many possible combinations of chromosomes which could unite at time of fertilization and, thereby, establish a different production potential.

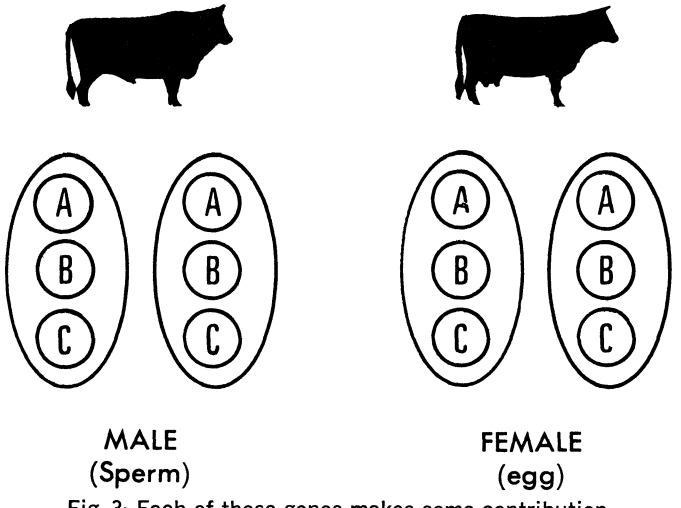


Fig. 3: Each of these genes makes some contribution to milk production.

Basically, this is the way inheritance works. Usually, there are several gene pairs involved in each individual characteristic. This is especially true for determining milk production. Some pairs are more desirable than others. Therefore, we have a wide range of differences among cows in their milk producing ability.

Reproduction

The dairy cow provides the egg, the environment in which the egg is fertilized, and the environment in which the new individual is nourished during development prior to birth. The cow also provides nourishment to sustain the calf immediately after birth. These functions are performed by the primary and secondary organs of reproduction. Figure 4 identifies and shows the location of these organs.

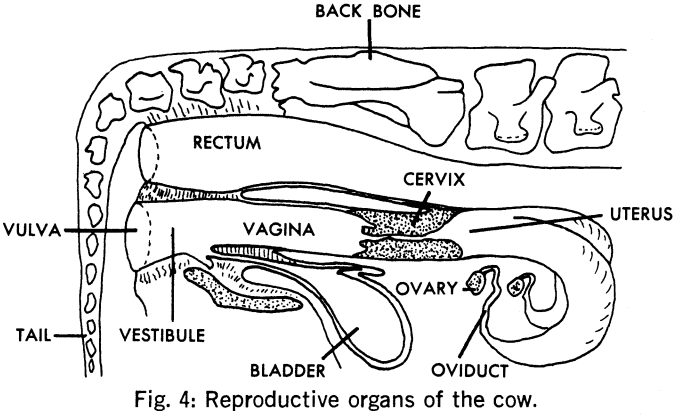


Fig. 4: Reproductive organs of the cow.

Parts of the Tract

The external part to the reproductive tract is the vulva. The vagina, sometimes referred to as the birth canal, extends from the opening of the bladder (urethra) to the cervix. The cervix is a tough muscular organ with a small center opening which leads to the uterus. During natural mating, the sperm are deposited posterior to (in back of) the cervix in the vagina, but in artificial insemination a small tube is passed through the cervix and some of the sperm are placed in the uterus.

During pregnancy, the cervix secretes a thick waxy substance which forms a "plug" to prevent entrance of foreign material into the uterus while the young calf is developing. The uterus, located anterior to (in front of) the cervix, is a cavity which serves to house and nourish the developing fetus

(unborn calf). It consists of a short body and 2 horns which have the appearance of a ram's horns. During pregnancy, it increases greatly in size to an organ capable of housing a 50 to 100-pound calf. The oviducts extend from the horns of the uterus to the ovaries and serve as a passage way for the sperm and egg. The sperm fertilizes the egg in the upper one-third of one of the oviducts. From here, about 4 days later, the fertilized egg descends to the uterus for growth and development.

How the Egg Is Formed

The 2 ovaries are the primary organs of reproduction in the cow. They produce eggs and hormones known as female hormones. Hormones are chemical regulators that control the functions of many different organs of the body. The hormones involved in reproduction travel through the blood stream from the glands, where they are produced, to the target organs where they have their effect. The ovaries are regulated by hormones from the pituitary gland, often called the master gland.

The reproductive activity of a normal, healthy female occurs in cycles on an average of every 21 days (range 18-24 days) until she becomes pregnant. During these cycles, the pituitary gland releases a follicle stimulating hormone (FSH) which causes the formation of a follicle (blister-like) on the ovary. Inside this follicle an egg is formed. As the follicle grows and matures, it produces the hormone estrogen. The secretion of estrogen reaches a peak when the follicle is almost ready to rupture and the egg is ripe or mature. At this stage, secretion of estrogen causes the cow to come in heat and stimulates the pituitary gland at the base of the brain to release the luteinizing hormone (LH) which in turn ruptures the follicle permitting release of the egg into the oviduct for fertilization.

When the follicle ruptures and releases the egg, the cavity left by the follicle is replaced by a yellow body known as a corpus luteum. The yellow body produces the hormone progesterone, known as the pregnancy hormone. If the egg is fertilized, the yellow body continues to function and prohibits the cow from returning in heat and maintains pregnancy through the production of progesterone. If the egg is not fertilized, the yellow body is resorbed, and the cow continues to repeat the 21-day cycle until pregnant.

Fertilization

The sperm fertilizes the egg in the oviduct. From here it descends to the uterus where it becomes attached to the uterus and a water sac (amnion) is formed around it, called the placenta. The young calf develops its own blood supply. There is no mixing of the blood of the young calf and its mother.

All of the body parts of the developing calf are formed by the 46th day of pregnancy. From this time on throughout pregnancy, the calf simply increases in size, see Table 2.

Table 2: Time Table of Development for the Calf

Time-Days	
0	Fertilization in oviduct
4	Reaches uterus
12	Attaches to uterine wall
18	Water sac encloses embryo
21	Heart begins to beat, reproductive tract starts development
23	Head region recognizable
25	Forelimb buds appear
30	First placental plates appear
37	Facial features appear
46	Now called a fetus (all parts are present)
60	Eyelids close
100	Horn pits appear
230	Hair covers body
279-290	Birth

The length of gestation (pregnancy) for the various dairy breeds is shown in Table 3.

Table 3: Normal Length Gestation by Breed

Breed	Days
Ayrshire	279
Brown Swiss	290
Guernsey	283
Holstein	279
Jersey	279

Parturition or Calving

Parturition or calving is brought about by the action of hormones. The hormone, relaxin, causes the reproductive organs of the birth canal to become relaxed so the calf can pass through. A hormone called oxytocin from the pituitary gland causes strong contraction of the uterus which forces the calf out through the cervix and through the birth canal.

Reproductive Performance

For ideal reproductive performance, each cow in a dairy herd should produce a calf a year. Regular calving means more milk, more herd replacements, and less time and expense for prolonged dry periods.

After a cow calves, it takes 60 days on the average before her reproductive tract returns to a normal, healthy condition. Thus, if a cow is bred 60 to 80 days after calving and given a 60-day dry period prior to the next calving, this would permit a 305 day lactation and a calf each year. No ill effects have been demonstrated due to breeding earlier than 60 days after calving; however, conception rate is usually lower than if a minimum of 60 days is allowed. There is also some evidence of more cows with retained placentas following early breeding. On the average, the first estrous cycle after calving occurs in 43 days.

Rectal palpation of a cow's uterus by a trained observer 30 to 45 days after calving will help to determine if the uterus is returning to normal. This method will often detect abnormalities prior to breeding and allow time for treatment so cows can be bred 60 to 80 days following calving and produce a calf each year.

Timing in Breeding

The length of a cow's heat period is usually about 18 hours (it may vary from 12 to 24 hours). Research shows that cows bred from mid-heat to 6 hours after the end of heat have the highest conception rate. A good rule of thumb in breeding is: Breed cows found in heat in the morning the same afternoon; breed cows in heat in the evening the following morning. This method will allow the cow time to reach mid to late heat before breeding.

Some of the signs of heat are:

1. Cow stands for other cows to mount
2. Flow of clear, transparent mucus from the vulva
3. Cow bawls and appears restless
4. Cow may attempt to ride other cows

Reproductive irregularities and disorders can be caused by disease, physiological defects, or embryonic death. These irregularities are primarily responsible for lowering the conception rate in dairy cattle.

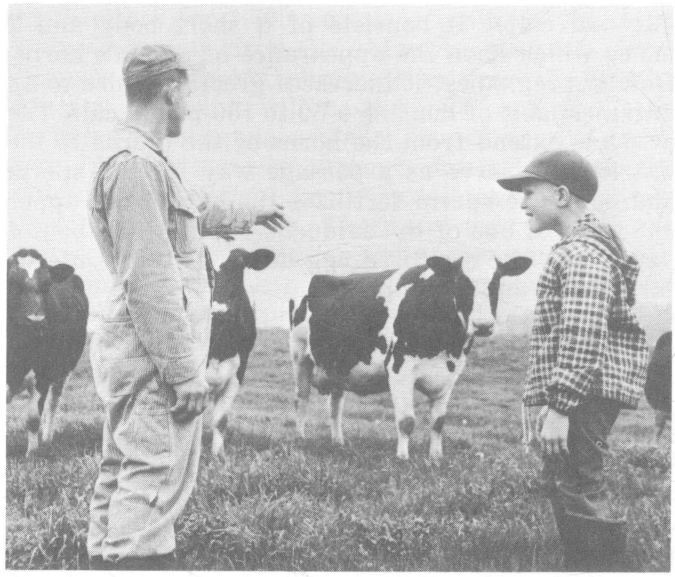
Suggestions for Improving Reproductive Performance

1. Keep accurate and complete records of heat, breeding and calving dates.
2. Observe cows twice daily for signs of heat.
3. Have cows checked 30-45 days after calving to determine if uterus is returning to normal.
4. Wait 60 to 80 days after calving to breed.
5. Use high conception sires.
6. Inseminate during latter part of heat.
7. Use services of veterinarian in all cases of difficult calving, retained placentas, and where there is evidence of disease and infection.
8. Provide good sanitation for cow and calf at calving time.
9. Provide adequate supply of phosphorus; a lack of phosphorus may cause silent heat.
10. Breed heifers to calve at 24 months or earlier if well grown.

References: Textbook—*Physiology of Reproduction and Artificial Insemination of Cattle,* by Dr. G. W. Salisbury and Dr. N. L. VanDemark, published by W. H. Freeman and Co., San Francisco, 1961. O.S.U. Extension Bulletin 485—*Developing a Modern Dairy Breeding Program,* Dr. Harry L. Barr. O.S.U. Mimeo—*Anatomy and Physiology of the Reproductive Tract.*

The Dry Cow

Successful calf raising begins with proper feeding and care of the dry cow. Nearly two-thirds of the development of the unborn calf takes place during the last few weeks of pregnancy. Though the fetal requirements for growth are not large, there is a relationship between the feeding of the dam and the vigor of the newborn calf. The nutritive value of colostrum is affected by the ration fed. Good quality forage supplemented by an adequate amount of grain can supply the dam's need for energy, protein, calcium, phosphorus and vitamins A and D.



Dry cows in good condition but not fat

Most cows should have a 6 to 8-week dry period prior to calving. This provides time to rebuild body reserves, regenerate secretory tissue in the udder, and enables the cow to adjust more smoothly to drastic hormonal changes shortly before and after calving.

Dry cows should be in good condition, but not fat, at time of calving. Generally, cows fed all the good forage they will consume plus ¾ to 1 pound of grain per 100 pounds of body weight will usually achieve the desired condition.

Finally, if the healthy, newborn calf is to survive the environment to which it must adjust, the dry cow should be managed so she will produce colostrum (first milk) containing maximum protective immunity against disease. Colostrum provides the only source of protection (passive immunity) for the calf against disease-producing microorganisms for about the first 2 months while its own immunological defense system (active immunity) is developing. The microorganisms to which the dry cow is exposed and against which she develops immunity in her colostrum may be quite different in the pasture, the dry cow barn, or maternity barn, compared to the organisms in the calf barn where the calf may be penned. Under such conditions, the calf may get little help from its dam's colostrum in resisting the disease organisms to which it is exposed.

Calf losses might be lowered and the need for antibiotics and medication drastically reduced, if dairy housing facilities are designed to permit calves to be raised where their dams were housed during the dry period. This would provide immunity in the colostrum for protection of the calf against the disease producing microorganisms in that particular environment.

The dry period offers many opportunities to increase the overall efficiency of the dairy enterprise.

Newborn calves receive colostrum first 3 days

It should be carefully planned, not regarded by the herdsman as a time for relaxation of management.

The normal gestation period by breeds is 279 days for Ayrshires, Holsteins and Jerseys; 283 days for Guernseys; and 290 days for Brown Swiss. It is good practice to observe the cow frequently as the date of calving approaches. If delivery is normal, the front feet appear first, followed by the nose. When the cow experiences difficulty, she should be given assistance by the herdsman or a veterinarian.

The Newborn Calf

As soon as the calf is delivered, the cow will normally lick it. This aids in drying off the calf and also stimulates circulation and breathing. When the cow fails to do this, rub the calf briskly with a clean, dry cloth. See that the nostrils are cleared of mucous to aid normal breathing. To prevent entrance of infectious organisms, paint the calf's naval with tincture of iodine (7%) soon after birth.

A healthy, thrifty calf is normally on its feet in 20 to 30 minutes and nursing within an hour. Calves that are too weak to stand in this length of time need assistance.

It is essential that a calf receive colostrum milk (first milk of mother) for the first 3 days. Colostrum is high in Vitamin A. A dairy calf is born with little or no Vitamin A reserve, and Vitamin A aids in keeping down respiratory and other infections. Colostrum further helps in activating the digestive system and provides additional protection against infection and disease through its antibody content.

Nutritive Requirements of Growing Calves

Feeding the dairy calf and heifer may be divided into 2 phases. In the first phase, from birth to 2 months of age, the calf functions largely as a monogastric animal and during the second phase, after 2 months, the calf becomes a full-fledged ruminant.

During the first phase, the rumen, reticulum, and omasum are small in size compared to the abomasum or "true" stomach.

The young calf has special requirements for protein, energy, and vitamins.

Protein

The first protein a calf receives comes from colostrum milk. The colostrum protein (21%) contains antibodies that may protect the calf from bacterial infections. Following the 3-day colostrum feeding period, the whole milk which the calf receives contains about 3½ percent protein. Calves shifted from whole milk to milk replacers usually have adequate animal protein in their diet because most replacers contain 60 to 90 percent of dried milk products. However, most replacers are low in fat, compared to normal milk. By the time the calf is weaned from milk or a milk replacer, the calf can utilize vegetable proteins. Table 4 gives a comparison of colostrum milk with normal milk.

Table 4: Average Composition of Colostrum Milk and Normal Milk

Constituents	Colostrum*	Normal Milk*
Total Solids	28.30 %	12.86 %
Ash	1.58 %	0.72 %
Fat	0.15 to 12.00 %	4.00 %
Lactose	2.50 %	4.80 %
Casein	4.76 %	2.80 %
Albumin	1.50 %	0.54 %
Globulin	15.06 %	.....
Total Protein	21.32 %	3.34 %

* Source: W. E. Peterson, "Dairy Science" Text

Table 5 gives an example of a suitable milk replacer formula.

Table 5: Example of Milk Replacer

Item	Amount in Pounds
Dried Skim Milk	70
Dried Whey	18
Lecithin	2
Animal Fat	10
Dicalcium Phosphate	1.7
$CuSO_4$	+
$FeSO_4$	+
$MnSO_4$	+
$CoSO_4$	+
Antibiotic	+

+ = Trace Amounts

Energy

The dairy calf exhibits its highest metabolic rate (rate at which it burns or utilizes energy) during the first 2 weeks of life. The source of energy during this period comes principally from the lactose and fat of milk or a good milk replacer. Calves require about 1.95 pounds of T.D.N. (Total Digestible Nutrients) per 100 pounds of body weight at this early age. Ten pounds of milk provide approximately 1.65 pounds of T.D.N. Therefore, to obtain continuous growth from birth, calves of the larger breeds need more than 10 pounds of milk per day during the first 2 weeks of life.

The young calf cannot digest starch or some sugars because certain enzymes are not present in the digestive tract at an early age. The calf also has certain limitations on the type of fat it can utilize. It can handle milk fat which is highly saturated but has limited ability to utilize the highly unsaturated fats such as corn oil and soybean oil unless homogenized. By the time the calf is consuming grain or starter at about 2 weeks of age, it normally has developed the ability to digest and use other energy sources such as starch.

Vitamins-Water Soluble

The newborn calf has requirements for vitamins similar to non-ruminants. Studies revealed that the young calf requires the water-soluble vitamins, thiamine, riboflavin, niacin, choline, biotin, pyriodoxine, folic acid, B 12, and pantothenic acid. The needs for these vitamins are met by the feeding of colostrum, whole milk and by most milk replacers. After the 7 to 8 week milk feeding period, the rumen microorganisms are able to synthesize the calf's needs for these vitamins.

Vitamins-Fat Soluble

The dairy calf has need for the fat soluble vitamins A and D. Vitamin A is essential for growth and disease resistance. At birth, the calf has a low storage of Vitamin A. Colostrum is a rich source of this vitamin. Whole milk from well-fed cows and good quality green forage are also good sources.

Young calves that don't get an adequate amount of Vitamin A during the early weeks of growth often die of scours and pneumonia. From information available, it is recommended that calves receive about 20,000 I.U. (International Units) of Vitamin A daily during the first 4 to 6 weeks of age. Most commercial milk replacers and calf starters are fortified with Vitamin A.

Vitamin D intake is also important during the first 3 months of the calf's life. Deficiency symptoms include stiffened gait, arched back, depraved appetite, and sometimes tetany develops. Calves should receive 300 to 400 I.U. per hundred pounds of body weight daily. Sun cured hay and direct sunlight are good sources of Vitamin D. Milk replacers and calf starters are often fortified with Vitamin D in the form of irradiated yeast or some other supplement.

Minerals

Calves require the same minerals for growth as do other mammals. During the milk-feeding period, most minerals are present in needed amounts except for some of the minor elements such as copper and iron. After the milk feeding period, provide calcium, phosphorus, and sodium chloride (common salt). Iodine and cobalt may be needed in some areas. An adequate amount of calcium and phosphorus is needed for proper bone formation. Daily calcium and phosphorus requirements for the young calf are about 7 to 8 grams of each per 100 pounds of body weight. These requirements can be met by including 1 percent steamed bone meal in the grain ration or calf starter plus free choice feeding.

Include common salt in the grain or starter mixture. The addition of a good trace mineralized salt to the mixture plus free choice in a box will usually provide the needs of iodine, cobalt, copper, and iron, if they exist.

Antibiotics

Antibiotics are added to commercial milk replacers and starters. They stimulate rate of gain for the first 8 to 10 weeks and help reduce the incidence of scours. Effect on rate of growth largely disappears after 10 weeks. An intake of 20 to 50 milligrams per calf per day is adequate. Most milk replacers and starters contain 20 to 40 milligrams of the antibiotic per pound.

Feeding Systems

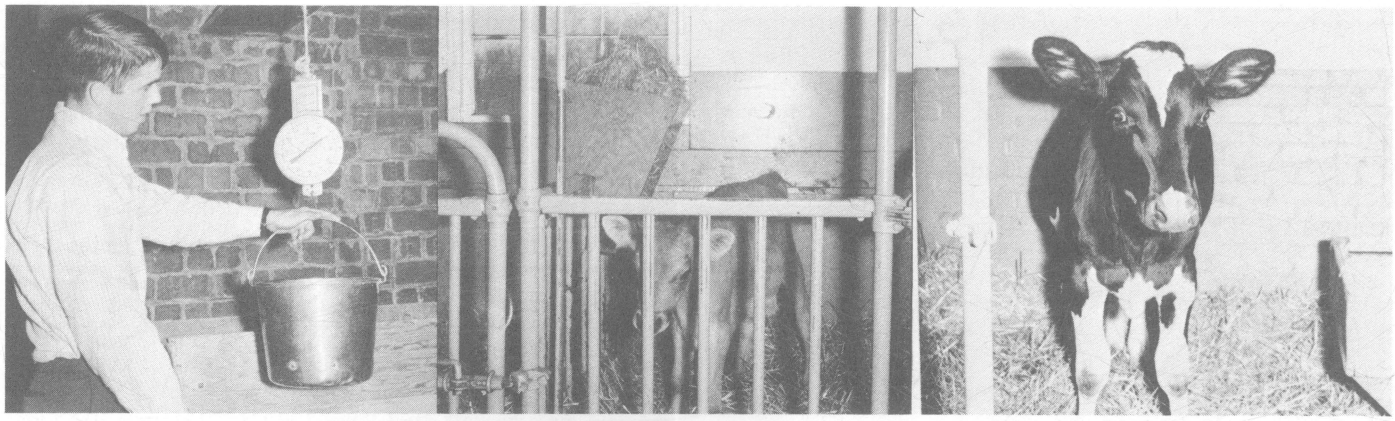
Birth to Six Months

Ohio dairymen use a number of systems for raising calves from birth to 6 months of age. The most popular one for many years has been the so-called "Limited-Whole-Milk Dry Calf Starter Method."

Ohio High Roughage System

Within recent years workers at the Ohio Agricultural Research and Development Center have developed and field tested what is known as the Ohio High Roughage System of Calf Raising. This method encourages early rumen function and, when properly followed, offers a low cost system for raising replacements.

The Ohio high roughage system involves limited milk feeding for 7 weeks; free choice feeding of good quality, mostly legume hay, after 3 days of age; and use of a simple grain ration limited to about one-half of the amount of hay consumed. This system encourages early rumen function and the synthetic processes which accompany it. The economy of the system stems from being able to make maximum use of good roughage and minimum use of high-cost grain and protein supplement. A successful milk feeding schedule includes whole milk, a milk replacer, or skim milk for the first 7 to 8 weeks. If a



Left—Weighing milk at each feeding helps prevent digestive upsets; center—calf receives high quality hay first week; right—calf grown using Ohio High Roughage System

milk replacer is used, it is recommended that whole milk be fed during the first 2 weeks. Ohio workers have found that in the high roughage system, feeding extra milk (above the old recommendation of 10 percent of body weight) during the first 2 weeks that calves will gain weight rather than merely retain birth weight or lose weight. Table 6 gives a recommended milk feeding schedule for use with the high roughage system.

Table 6: Recommended Whole Milk Feeding Schedule

Age	Large Breeds lbs. Daily*	Medium Breeds lbs. Daily*	Small Breeds lbs. Daily*
1 (0-3 days)	Colostrum	Colostrum	Colostrum
1 (4-7 days)	16	14	10
2 **	12	10	8
3	10	8	6
4	10	8	6
5	10	8	6
6	9	6	6
7	4	4	4
8	0	0	0

* Feed ½ the daily amount at each of 2 feedings. If calves scour, milk feeding should be reduced.

** Milk replacer can be substituted for whole milk after the second week. Calves that are weak or slow to start eating dry food may need to have the milk feeding period extended.

Calves may be fed milk or milk replacer from either an open pail or a nipple pail. Wash and sanitize all pails after each feeding. Dirty pails and contaminated milk are frequent causes of scours.

The feeding of high quality, soft-textured hay (containing ½ to ¾ legumes) should begin at 4 days of age. Feed hay free choice and give calves 10 to 15 percent more than they will clean up. Place fresh hay in the rack each day. Hay which calves refuse can be fed to older animals or used for bedding.

Feed calves a simple grain ration beginning at 5 weeks of age. Feed grain so a 2 to 1 hay to grain ratio can be maintained. Limit grain feeding to 4 pounds per day for the large breeds, 3.6 pounds for the medium breeds, and 3.0 pounds per day for the small breeds. A 15 percent (total protein) grain ration is adequate with high quality forage. In many instances, the regular dairy herd ration would be satisfactory. Table 7 lists a ration that could fulfill the needs of the High Roughage System.

Table 7: Suggested Grain Mixtures

Ingredient	Amount in Pounds
Ground Shelled Corn	500
Ground Oats	355
Soybean Oil Meal	125
Iodized Salt	10
Steamed Bone Meal	10
TOTAL	1,000*

* 15% Total Protein

To achieve a 2 to 1 hay to grain ratio, it is necessary to limit the amount of grain fed daily. Table 8 contains a suggested grain feeding schedule which, if followed along with free choice hay feeding, will result in about a 2 to 1 hay to grain ratio.

Table 8: Suggested Grain Feeding Schedule

Age	Large Breeds lbs. Daily	Medium Breeds lbs. Daily	Small Breeds lbs. Daily
0-4	0.0	0.0	0.0
5	0.3	0.3	0.2
6	0.5	0.5	0.4
7	0.7	0.7	0.6
8	1.0	0.9	0.8
9-10	1.3	1.2	1.1
11-12	2.0	1.8	1.5
13-14	2.5	2.2	1.8
15-16	3.0	2.6	2.0
17-18	3.3	3.2	2.2
19-20	3.8	3.6	2.4
21-22	4.0	3.6	2.6
23-24	4.0	3.6	2.8
25-26	4.0	3.6	3.0

The amounts of grain fed during the weeks indicated will approximate a 2 to 1 hay to grain ratio based on the average calf of each breed. Adjustments should be made for extra large or extra small calves.

The approximate amounts of feed needed to grow dairy replacements to 6 months of age using the high roughage system are shown in Table 9.

Table 9: Approximate Feed Needs Through Six Months

Feed	Large Breeds (lbs.)	Small Breeds (lbs.)
Milk	450	300
Grain	410	290
Hay	850	600

The approximate cost of feed for raising replacements to 6 months of age with this system using a value of $5 per cwt. for whole milk, $60 per ton for concentrates, and $35 per ton for good quality hay is shown in Table 10. Further details on the High Roughage System are to be found in OARDC—Dairy Science Series 5 (11) : Nov. 1961 and Research Bulletin 918, 1962.

Table 10: Approximate Cost of Feed Through Six Months

Feed	Large Breeds $	Small Breeds $
Milk	22.50	15.00
Grain	12.30	8.70
Hay	14.90	10.50
TOTAL	$49.70	$34.20

Limited Whole-Milk Dry Calf Starter System

The same suggestions as outlined for milk and hay feeding under the high roughage system can be applied here except that reduction of milk be started sooner and calves can be weaned somewhat earlier when a palatable calf starter ration is fed free choice.

Calves usually eat a limited amount of dry starter beginning the second week. To get a calf started to eating the mixture, rub some in its mouth or place a small amount in the pail after feeding milk. After the calf has started eating the mixture, place fresh starter in the feed box each day. Feed approximately what the calf will clean up.

Feed calves all the starter they will eat until those of the smaller breeds are consuming 3 pounds per day and those of the larger breeds 4 pounds per day. This rate of consumption will often be reached at 8 to 12 weeks of age depending on individual calves. Feed good hay free choice in addition to the starter ration. At 3 to 4 months of age, begin the change over to a grain concentrate ration similar to the one suggested for the high roughage system or the regular herd ration. If good forage is available, continue to feed this concentrate ration at the same level until calves are 6 months of age or older depending on growth and condition. If forage is of poor quality or calves are thin, feed extra grain. Likewise, if calves begin to take on an overconditioned appearance, reduce grain feeding.

The approximate amounts of feed needed to grow replacements to 6 months of age using the limited whole-milk dry calf starter system are set forth in Table 11.

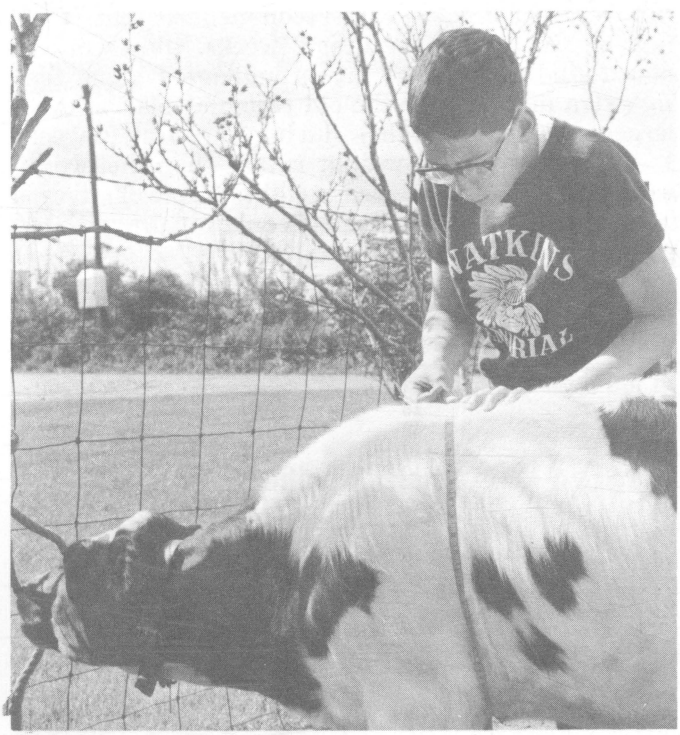
Table 11: Approximate Feed Needs Through Six Months

Feed	Large Breeds lbs.	Small Breeds lbs.
Milk	350	200
Starter	300	225
Grain Mixture	300	225
Hay	700	500

The estimated cost of feed for raising replacements through 6 months of age with this system, using a value of $5 per cwt. for whole milk, $3 per cwt. for concentrate, $6.50 per cwt. for calf starter, and $35 per ton for good quality hay, may be found in Table 12.

Table 12: Estimated Feed Cost Through Six Months

Feed	Large Breeds $	Small Breeds $
Milk	17.50	10.00
Starter	19.50	14.60
Grain Mixture	9.00	6.75
Hay	12.25	8.75
TOTAL	$58.25	$40.10



Taping calf to check growth

Of the 2 systems discussed, either one, if carefully followed, will produce good results. When high-quality forage is available, the high roughage system offers an advantage in cost.

Growth to Expect at Six Months

Heifers should be kept in a thrifty, growthy condition but not fat. Research results show that overconditioned heifers fail to produce as well as those which make normal gains.

Daily rates of gain which dairymen should expect for heifers through 6 months of age are shown in Table 13. Rates of gain for 89 heifers raised in 7 Ohio counties in the high roughage field demonstrations are also listed in Table 13. (OARDC Research Bulletin 918, 1962)

Table 13: Average Daily Rate of Gain Through Six Months by Breeds

Breed	Expected Pounds Per Day	High Roughage Field Demonstration Pounds Per Day
Ayrshire	1.3	1.41
Brown Swiss	1.5	1.75
Guernsey	1.2	1.51
Holstein	1.5	1.74
Jersey	1.1	1.15

The average weights and heart girth measurements of different breeds are shown by months in Table 14.

Table 14: Normal Weight and Heart Girth Measurement (inches) by Month by Breeds

	Ayrshire		B. Swiss, Holstein		Guernsey		Jersey	
Month	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches
Birth	72	28.9	90	30.8	65	28.2	53	27.4
1	89	31.1	112	33.9	77	30.4	67	29.8
2	119	34.3	148	37.0	102	33.4	90	32.5
3	158	37.6	193	39.9	133	36.5	121	35.4
4	198	40.8	243	42.9	173	39.4	158	38.1
5	245	43.2	297	46.0	216	42.0	199	40.9
6	293	45.4	355	48.7	260	44.6	243	43.7

Reference: Ragsdale, A. C., Growth Standards For Dairy Cattle, Missouri Agricultural Experiment Station Bulletin 336: 1-12 Reprinted 1942.

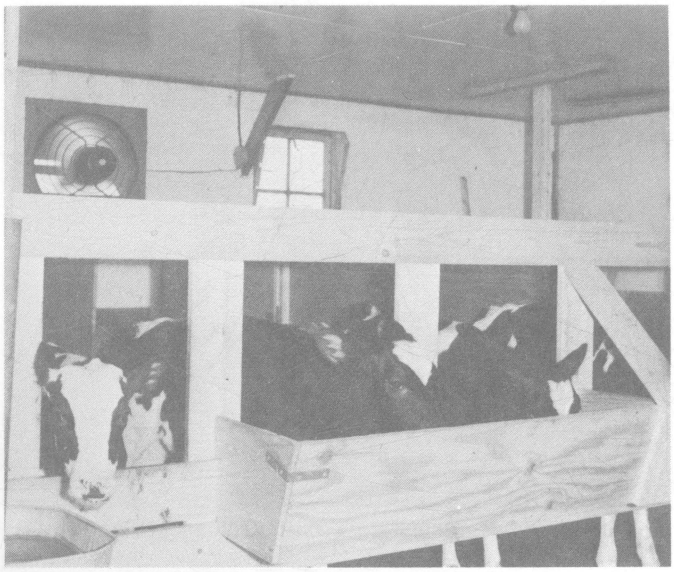
Management Suggestions for Calves, Birth Through Six Months

Raise calves in quarters that are clean, well lighted, sufficiently ventilated, and free from drafts and dampness. Damp stalls, moist bedding, presence of drafts, and poor lighting each can have an affect in lowering a calf's resistance to infection. To provide this type of environment, the housing need not be elaborate nor expensive.

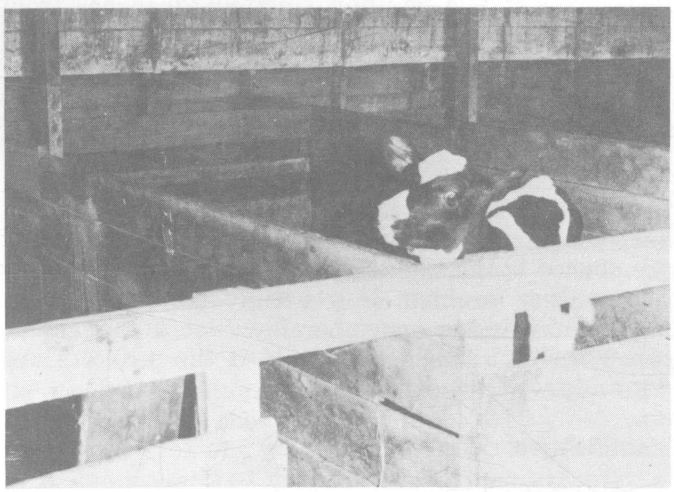
If possible, calves from birth to at least one week after weaning from milk should be raised in individual pens. If individual pens or stalls are not available, tie or stanchion calves at feeding time. This prevents them from sucking one another after milk feeding.

A 4 by 6-foot (24 square feet) pen with solid partitions and a slatted front helps prevent drafts and, at the same time, permits good air circulation. This type of pen has adequate space, keeps calves from coming in contact with one another, and thereby aids in disease control. Each pen should have a feed box (8 x 10 x 6-inches deep), hay rack, and water bowl or a frame for holding a water pail. If feed and water can be provided outside the pen, less contamination from feces will result and more room will be available inside the pen for the calf to move around.

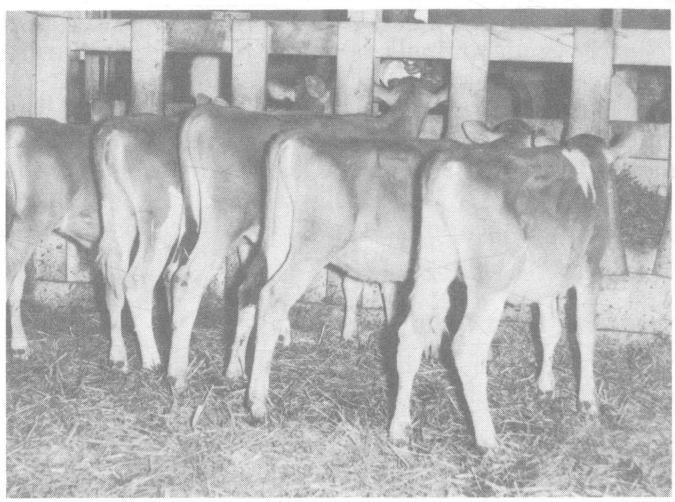
Calves 8 to 12 weeks of age may be sorted by size and raised in groups. About 10 calves should be the maximum number raised per group. Generally, age difference should not exceed 2 months. If calves are of different breed, group them according to size. Provide a minimum of 30 square feet of floor space per calf when calves are raised in groups. An automatic drinking cup is preferred for calves rasied in groups. A feed trough 10 inches wide by 6 inches deep and allowing 2 feet per calf is adequate.



Clean, well-ventilated quarters cut calf losses

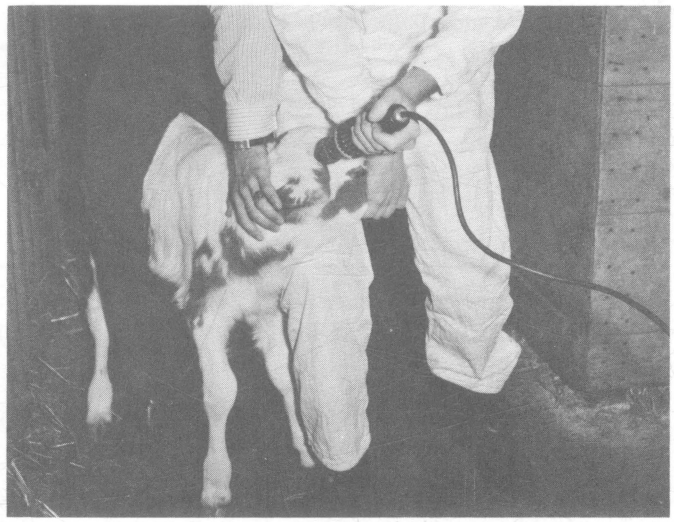


Individual pen housing until weaning



Grouped by size and age after weaning

Well-ventilated, temperature-controlled calf raising barn



Electric dehorners are used by some dairymen to remove horn buttons

In both individual and group pens, the top of the feed boxes should be approximately 20 inches from the floor. Locate feed boxes away from the water supply to minimize contamination.

Clean calf pens and provide fresh bedding daily. When calves are removed from pens, thoroughly clean them before new calves are brought in.

If special calf barns are used, it may be necessary to supply artificial heat to prevent freezing and to keep the barn free of dampness in winter. If calves are housed in the same barn as the milking herd, the temperature problem is generally eliminated. The important thing to remember, however, is that calves can withstand considerable cold if the quarters are dry and free from drafts.

Identification

All calves should be permanently identified soon after birth. For registration of purebreds, proper identification is a must. It is also highly desirable to identify grade animals as an aid in keeping accurate production, breeding, and herd health records.

Owners of purebred calves should follow the rules of identification of their respective breed association. Identify grade calves with either the new series DHIA, AI, or Disease Control tags. Enter proper identification for each calf in a permanent record book.

Removing Extra Teats

Calves born with extra teats should, in most cases, have them removed before the calves are a year old. Extra teats detract from the appearance of the udder and may interfere with milking.

Before removing an extra teat, disinfect the teat and surrounding area with tincture of iodine or some other reliable disinfectant. Draw the teat down and snip it off at the line where it joins the udder with sharp scissors or shears. After the operation, again disinfect the area. In older heifers, the wound may be large enough to require stitches for proper healing. When extra teats are not readily distinguishable, or if attached to one of the normal teats, consult a veterinarian.

Dehorning

Dehorning is an important factor in good management. Cattle without horns are no longer discriminated against in the show ring, but more important, cows handled in loose-housing or free-stall and cows on pasture are much less subject to injuries.

One of the best times to remove horns is when the horn buttons first appear. This can be done as early as 1 to 2 weeks of age. When a good job of dehorning is done early, the animal will usually have a smooth poll.

There are a number of methods used to remove horns. One involves the use of electric dehorners. When using this piece of equipment, follow the directions of the manufacturer. Another method is to use caustic potash either in paste or stick form. When using the stick, clip the hair from around the horn buttons, moisten the stick, and rub the horn buttons vigorously until some bleeding occurs. Encircle the horn area with vaseline or grease to pre-

Clean, damp-free quarters prevent losses

vent any excess caustic from running down the face and getting into the eyes.

Before applying, wrap caustic stick with paper or cloth to protect your hands. When using the caustic paste, apply according to manufacturer's directions.

Sanitation

Thoroughly wash and sanitize all feeding pails after each feeding. Clean mangers and feed boxes regularly to prevent calves from eating moldy and contaminated feed and to increase feed consumption. Clean equipment and surroundings can do much to prevent digestive upsets and keep down disease.

Pasture and Silage

Both good pasture and good silage can replace hay in calf rations after about 4 months of age. Relatively speaking, corn silage is a low protein feed and legume grass silage is a low energy feed. Thus, each must be supplemented properly to give good growth. Often the management problems associated with feeding calves on pasture make it more practical not to use it.

Calfhood Vaccinations

In June 1964, Ohio met the requirements for a Modified Certified Brucellosis Area. This means that less than 1 percent of the Ohio cattle and less than 5 percent of the herds are known to be infected with Brucellosis (Bangs Disease). The ultimate aim in Ohio and throughout the nation is total eradication.

As an aid for control of the disease, dairymen are urged to vaccinate calves between 3 and 6 months of age. Calves vaccinated beyond 6 months of age are more apt to retain a positive reaction to the milk ring and blood tests. Beginning January 1, 1970, a brucellosis herd test shall include official vaccinates over 20 months of age. Vaccination against other diseases such as Leptospirosis, Enzootic Pneumonia, and Blackleg need only to be done where indicated and recommended by the veterinarian.

Calf Ailments

Young calves are subject to a number of diseases and ailments. Some diseases are contagious and cause a high death rate. Others, while the calf may recover, may result in a severe set back in its development. Close observation and proper care and management during the early weeks of the calf's life can do much towards prevention and control of disease.

Common Scours

One of the more common calfhood ailments is common or non-infectious scours. Symptoms include looseness of bowels wtih the feces being thin, watery, and foul smelling. This form of scours generally occurs in calves 1 to 3 weeks of age. Common scours usually indicates an upset digestive system and may result from many causes. Some of the common ones are use of dirty feed buckets, poor, overall sanitation; and cold, damp quarters. Treatment is largely a matter of finding and correcting the feeding and management practices causing the trouble.

White Scour (Infectious)

White scours is caused by a virus or bacterial infection and usually affects calves in the first 2 weeks, often soon after birth. The symptoms are marked looseness of the bowels and thin feces, grayish-white in color and foul smelling. Eyes of the calf are sunken. The calf becomes dehydrated, weak, and often dies within 2 days after the symptoms first occur. Prevention is extremely important because treatment is seldom effective after symptoms develop. Feeding colostrum milk and following good sanitation practices are helpful in prevention. The use of sulfa drugs and antibiotics may be of some help in treatment but should be given only upon the advice and recommendation of a veterinarian.

Pneumonia

Pneumonia may result as an aftermath of scours. Calves housed in damp, drafty, poorly ventilated quarters or those deficient in Vitamin A are more likely to develop pneumonia. The pneumonia may be of an infectious nature, thus infected calves should be isolated. Coughing, rapid breathing, and high temperature are the usual symptoms. The best treatment is use of one of the antibiotics, and/or sulfa drugs as prescribed by a veterinarian.

Ringworm

Ringworm is a fungus infection of the skin. The The hair usually comes off leaving scabby, crusted, circular areas. These may develop on the head, neck, shoulders, and other parts of the body. It is contagious to both man and other animals upon direct contact. For treatment, scrub the infected areas with a stiff brush and soapy water. Then paint these areas with tincture of iodine or some other fungicide recommended by a veterinarian.

Lice

Lice on animals cause discomfort, a rough unthrifty appearance, and prevent good growth in calves and heifers. Many good commercial louse powders are on the market. When applying any powder, be sure to cover all parts of the animal including the inside of the ears and the wrinkles along the neck. Treat all animals, not just the ones with lice, and repeat the treatment in 10 to 15 days to kill lice that hatch following the first treatment.

Internal Parasites

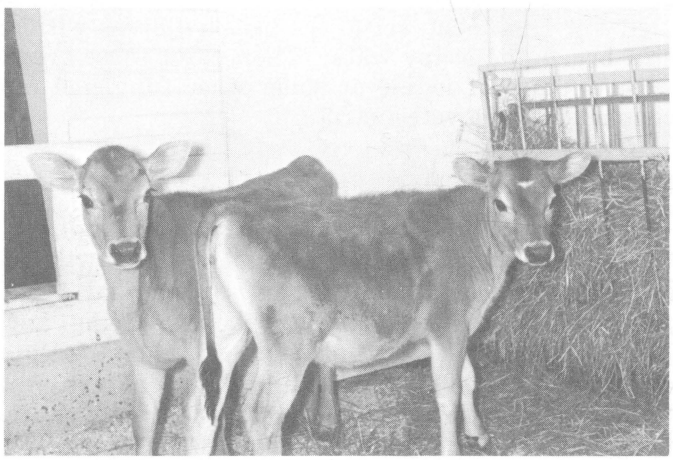
Calves and heifers infested with intestinal parasites may appear unthrifty and have a rough hair coat, poor appetite, characterized by loss of weight, and often a bloody diarrhea. Spread from one animal to another is from ingestion of eggs or young parasites in the feed and bedding. Some drugs are effective in treatment but good management and sanitation will do much to prevent infestation. Before using drugs consult your veterinarian. Keeping calves under 6 months of age away from older animals and off permanent pasture lots is a good preventative measure when parasites are a problem.

Raising Heifers from Six Months to One Year

After heifers reach 6 months of age, good growth without fattening can be achieved by feeding an abundance of good quality forage along with an adequate amount of a simple grain mixture (14-16% crude protein). Often, the same mixture being fed the dairy herd is satisfactory. The hay (or hay equivalent if pasture and/or silage is fed) to grain ratio should be limited to a 2 to 1 ratio. If high quality forage is fed, heifers of the large breeds can be limited to 4 pounds of grain per day and those of the smaller breeds to 3 pounds of grain per day. When forage is of poor quality or in limited supply, grain feeding may need to be increased above these amounts.

When available, the roughage can be good quality silage or pasture. Heifers on pasture should have free access to fresh water, iodized salt, a high phosphorus mineral mixture (steamed bone meal, di-calcium phosphate are examples), and adequate shade and protection from flies. Heifers on pasture and those receiving silage should also be fed some hay.

As previously mentioned, calves after the milk feeding period may be housed in groups. Calves 6 to 12 months of age when handled in groups of 5 or more, should be about the same age and/or size.



Six-month-old calves gain well on good quality hay and simple grain ration

As a guide in checking growth rates of heifers from 7 months through 12 months of age, normal weights and heart girth measurements may be found in Table 15.

Table 15: Normal Weights and Heart Girth Measurement for Calves 7 months Through 12 Months of Age by Breed

	Ayrshire		B. Swiss, Holstein		Guernsey		Jersey	
Month	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches
7	344	47.9	410	51.1	305	47.1	286	46.3
8	389	50.2	462	53.2	359	49.3	324	48.4
9	433	51.3	509	54.6	389	50.7	360	50.1
10	469	52.8	552	56.3	427	52.1	393	51.5
11	502	54.2	593	58.2	459	53.5	420	52.8
12	538	55.7	632	58.9	490	54.8	450	54.0

Reference: Ragsdale, A. C., Growth Standards for Dairy Cattle. Missouri Agricultural Experiment Station Bulletin 336: 1-12 Reprinted 1942

Raising Heifers Twelve Months to Freshening

Heifers that have made normal growth as calves through 12 months of age can be grown to freshening age by feeding maximum amounts of good quality forage and a minimum amount of a simple grain mixture. Improved pasture, good quality hay, and silage are all suitable forages for yearling heifers when fed alone or in combination with each other.

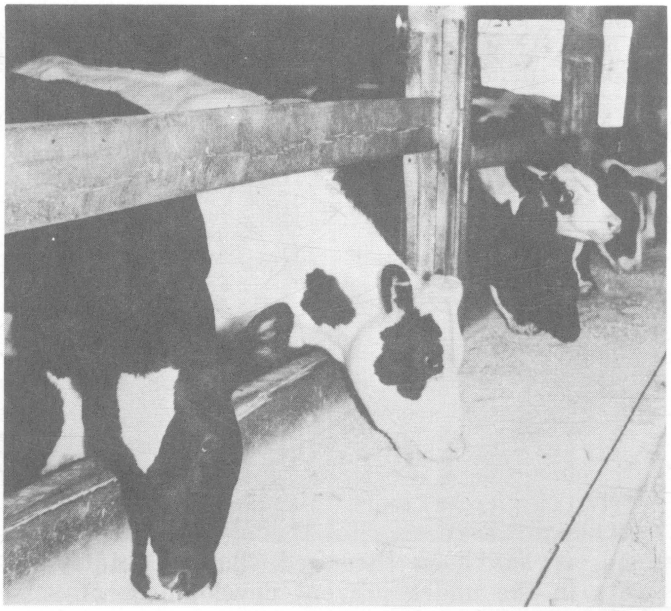
If heifers are to reach good size as 2-year olds, they should be kept growing continuously from birth to freshening. A suggested average daily gain to strive for from birth to 2 years of age is listed by breed in Table 16.

Table 16: Average Daily Gain-Birth to Two Years

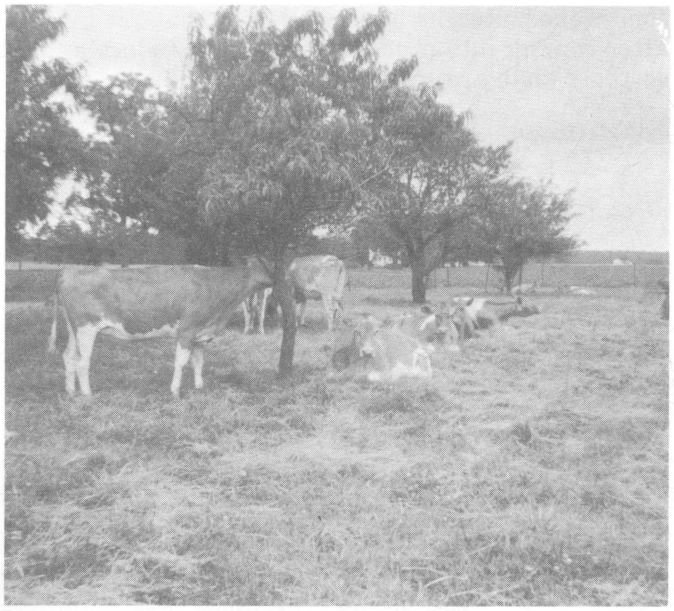
Breed	lbs./Day
Ayrshire	1.2
Brown Swiss	1.4
Guernsey	1.1
Holstein	1.4
Jersey	1.0

Reference: Cornell Extension Bulletin 761. Raising Dairy Calves and Heifers, 1962

One of the best ways to determine how well calves and heifers are being fed and managed is to check growth rates periodically against a normal standard. If scales are not available, the weights of dairy heifers can be estimated from heart girth measurements. Use a tape measure and place it around the heart girth just behind the front legs and shoulders. Make sure the animal is standing squarely on its legs and then draw the tape firmly at the point of withers and take the reading. Some feed companies have tapes that give a direct reading of the estimated weight of an animal. Using an ordinary tape measure and referring to Table 17 will provide a check with normal growth standards by breed from 13 months through 24 months of age.



Normally, ration fed milking herd is suitable for yearlings in winter



Yearling heifers can make satisfactory growth on good quality pasture alone

Table 17: Normal Weights and Heart Girth Measurements For Heifers 13 Months through 24 Months of Age by Breed

	Ayrshire		B. Swiss, Holstein		Guernsey		Jersey	
Month	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches	Weight lbs.	Heart Girth Inches
13	577	56.6	671	59.8	524	55.9	479	55.3
14	611	57.8	705	61.4	556	57.0	507	56.3
15	638	59.3	746	62.6	584	58.4	530	57.5
16	669	59.9	782	63.6	605	59.4	558	58.6
17	697	60.5	809	64.2	634	60.0	580	59.5
18	725	61.3	845	64.9	663	60.6	601	60.0
19	756	61.4	878	65.5	686	61.2	622	61.1
20	793	63.3	912	66.7	712	62.6	642	61.9
21	818	63.3	952	67.9	737	63.0	665	62.8
22	844	64.6	986	68.8	763	64.2	684	63.8
23	871	64.8	1024	70.1	788	64.6	708	64.5
24	902	66.6	1069	71.3	818	65.8	733	65.3

Reference: Ragsdale, A. C., Growth Standards for Dairy Cattle. Missouri Agricultural Experiment Station Bulletin 336: 1-12 Reprinted 1942

Feeding Yearlings in Winter

Yearlings should have free access to good quality forage in the form of hay and/or silage. Heifers should consume 2 to 2½ pounds of hay or its equivalent in silage per hundred pounds of body weight daily. To illustrate the conversion of silage to hay equivalent, 2 pounds of silage with a dry matter content of 45 percent or 3 pounds of silage with a dry matter content of 30 percent would equal 1 pound of hay equivalent.

The amount and protein content of the concentrate fed will depend upon the kind, quality and amount of forage eaten, and the condition of the heifers. In most instances, the ration fed the milking herd is suitable. When good quality forage is fed, a ration containing 10 to 12 percent total protein is adequate and when the forage is medium in quality, feeding 2 to 4 pounds of grain daily will generally produce satisfactory growth. Heifers that are thin and not growing normally may need more grain to supplement their roughage intake.

Feeding Yearlings In Summer

If good quality pasture is available and abundant, yearling heifers will often make good gains with little or no grain. When pasture is not available or is of poor quality and in short supply, then yearlings should be fed much the same as recommended for the winter months.

Yearling heifers need a plentiful supply of clean, fresh water the year-round. A good supply of water in the pasture areas is very important. Heifers consume more pasture where water is readily available.

Heifers on pasture should also have access to plenty of shade and salt. If they are receiving little or no grain, it is also advisable to provide a good calcium-phosphorous supplement such as steamed bone meal.

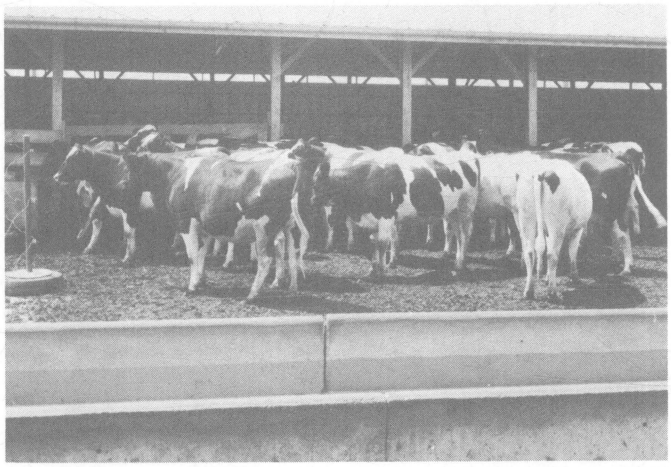
Housing Yearlings

From the labor standpoint, loose-housing or free-stall are the most efficient methods of housing. Often, both forage and grain can be fed automatically when these types of housing are used. A low cost, shed-type structure open to the east gives satisfactory protection from wind, rain, and snow. Approximately 40 to 50 square feet of floor space and 2 feet of feeding space per head is needed.

Heifers may also be housed in stanchions using the conventional platform and gutter arrangement. Regardless of method of housing, heifers should have access to an adequate, well-drained exercise lot. For ease of cleaning and outside winter feeding, at least a portion of the lot should be paved.

Feed and manage calves and yearling heifers so they will make normal gains but not be over-

conditioned .Recent findings reveal that fat heifers, after coming into production, do not produce as well as those that are grown normally.



Loose-housing or free-stall are the most efficient types of housing

Effects of Over-conditioning

The effect of plane of nutrition during early life upon the performance of dairy cows was studied by Cornell workers using Holsteins. Calves were assigned at random to 3 groups and fed at low (65%) medium (100%) and high levels (140%) of nutrition from birth to first calving. Nutrition levels were based upon Morrison's energy standards for growth and maintenance. From first calving to second calving, those grown at low, medium, and high planes of nutrition to first calving received 118 percent, 109 percent and 100 percent of Morrison's standards, respectively. From second calving on, each group was fed at 100 percent of Morrison's standards for production, maintenance, growth, and reproduction. Services required or first conception were not significantly different. Heifers raised on the low plane required 1.55 services, those on the medium, 1.41 and those raised on the high plane of nutrition required 1.48 services per first conception.

This is a longtime experiment, but results to date indicate that heifers raised on a high plane of nutrition until first calving fail to produce as well as those fed at either the medium or low plane.

Average body weight and average milk production by lactation for animals fed at the 3 planes of nutrition are set forth in Tables 18 and 19.

Table 18: Average Weight of cows Before Calving by Nutrition Level

Calving	Low (65%) lbs.	Medium (100%) lbs.	High (140%) lbs.
1st	969	1188	1353
2nd	1379	1442	1544
3rd	1520	1545	1636
4th	1601	1563	1676
5th	1604	1615	1727
6th	1626	1614	1745
7th	1631	1625	1731
8th	1642	1612	1734

(J. T. Reid, Cornell University)

Table 19: Average Lactation Yield of Milk by Nutrition Level

Lactation	Low (65%) lbs.	Medium (100%) lbs.	High (140%) lbs.
1st	8,840	9,083	9,226
2nd	10,450	10,450	9,752
3rd	10,932	11,438	10,777
4th	11,827	11,223	10,713
5th	13,225	12,966	10,887
6th	13,385	11,772	11,322
Total of Avgs. for 6 lactations	68,659	66,932	62,677

(J. T. Reid, Cornell University)

Tennessee workers, where identical twin Jersey heifers were used, obtained similar results. In this study heifers fed according to Morrison's Standards (100%) outproduced those fed at a high level of nutrition (153%) for the first 2 lactations by giving nearly 12½ percent more milk.

Though the reasons for this are not fully understood, it has been theorized that (1) fatty deposits in the udder prevent development of some of the secretory cells; (2) possibly over-conditioning reduces the ability of the cow to produce an adequate supply of the lactogenic hormone (the one responsible for initiation of production and persistency of production), thus preventing her from being able to express her true inheritance; and (3) the resulting additional body weight requires a greater amount of feed for maintenance. Some workers have also observed that the udders of cows over-conditioned as calves and heifers have a more meaty texture. As a result, the circulation or blood flow to and from the udder may be somewhat reduced.

Until more information is available, follow Morrison's Standards as closely as possible when growing replacements.

When to Breed Heifers

In general, heifers of each of the 5 major dairy breeds that have made normal growth may be bred at 15 months of age. Dairymen may want to breed some heifers at an earlier age and others beyond 15 months to comply with fall calving schedule.

For a guide on size and age to breed heifers, see Table 20.

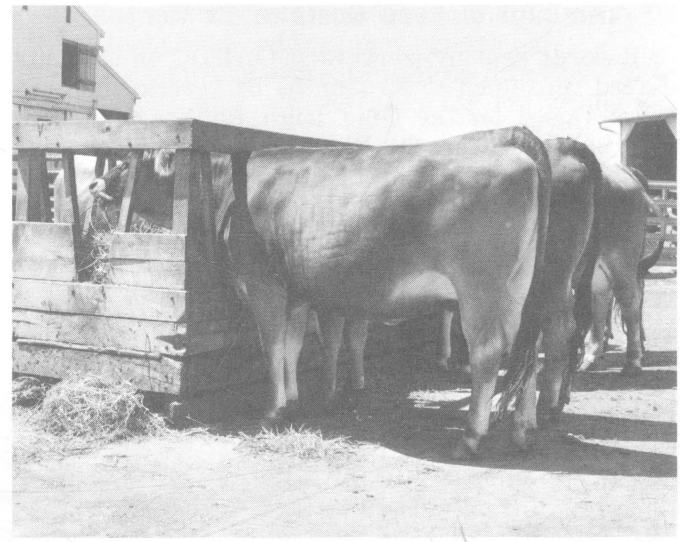
Heifers bred to calve early (before 24 months of age) should have feed intake restricted during the last 6 to 8 weeks before they are due to calve. This could aid in reducing the size of the calf and help prevent difficulty at calving. Early breeding of well-grown heifers could allow up to an extra lactation, shorten the "boarding" period and increase the overall efficiency of dairy production.

Table 20: Approximate Size and Age to Breed

Breed	Size (lbs.)	Age (Months)
Ayrshire	600	15-18
Brown Swiss	750	15-18
Guernsey	550	15-17
Holstein	750	15-18
Jersey	500	15-17

Reference: Cornell Extension Bulletin 761. Raising Dairy Calves and Heifers, 1962

A well-grown heifer to calve at two years of age



Bred heifers well-grown but not fat

Feeding and Care of the Bred Heifer

The bred heifer can be fed and handled in the same manner as other yearlings until the last 2 or 3 months of pregnancy. The last 3 months before an animal is due to calve is the period in which the unborn calf makes nearly two-thirds of its growth. Therefore, during this time a bred heifer may need extra grain for condition, growth of the fetus, and her own growth. Heifers may require as much as 8 to 10 pounds of grain daily a few weeks before calving. On the other hand they may need very little, if any, grain. The main precaution is not to get them fat.

At least 2 months before calving, it is good practice to introduce the bred heifer to the milking herd. This permits her to become accustomed to the other cows and the new premises. Some dairymen run heifers through the milking parlor for a period before they calve. All these practices are aids in training the heifer in good milking habits.

Life-long milking habits are often formed by the way a heifer is trained and milked at first calving. First calf heifers should be handled gently and properly prepared for rapid milking.

After lactation has begun, keep in mind that first calf heifers are still growing. Therefore, they should be given an extra allowance of protein and energy (grain) above the requirements for maintenance and milk production so that they can milk to capacity and finish growing at the same time. Growing herd replacements for maximum lifetime production actually extends from the time the calf is conceived, involving the prenatal nutrition of the dam, until maturity has been reached. The time is past when lax calf raising procedures and haphazard heifer feeding and management can be practiced, if dairymen are to compete favorably under present economic conditions.

Cost of Raising Dairy Replacements to 25 Months

How much does it cost to raise a replacement? What is the relative importance of the different items of cost?

The major expense in raising dairy herd replacements is feed. Studies conducted by workers in Ohio, New York, New Jersey, Nevada, New Hampshire and other states show that feed costs on the average account for 60 to 65 percent of the total cost of raising replacements. Since feed is the highest cost item, a feeding program based upon maximum use of low-cost, high-quality forage would seem to offer the most economical approach to the dairy herd replacement enterprise.

Other items of expense included in total cost could be grouped under the following headings: Labor, building use, interest on investment in replacements, breeding fees, bedding, cost or value of heifers at birth, and miscellaneous. Expenses that could be grouped under miscellaneous are veterinary service, medicines, disinfectants, supplies, insurance, registration, telephone, and electricity.

Most studies indicate that chore labor directly related to raising heifers from birth to first calving ranges from 30 to 45 hours per heifer. When calculating costs, other than feed, of raising your own replacements, the following is offered as a guide. Forty hours is a good average figure to use for the large breeds and 35 hours for the small breeds in figuring labor costs. Farm management authorities are presently assigning a wage rate of $2.00 per hour.

Bedding requirements from birth to 2 years of age (age first freshening) range from 1 to 2 tons per head with a current estimated value of $15 per ton. Breeding fees, in general, range from $6.50 to $8 per head. Interest on investment per heifer is usually charged at the rate of 5 percent; charge for building use, from 3 to 4 percent of the total cost; and miscellaneous costs at 4 to 5 percent of the total cost.

Amount of Feed Costs to 25 Months

Records kept by workers at OARDC on amounts of feed consumed to 25 months by several hundred claves raised on the Ohio High Roughage System have been used as the basis for determining feed costs. Feed consumption by dairy heifers, both large and small breeds, raised on this system from birth to 25 months of age are shown in Table 21.

Table 21: Feed Consumed to 25 Months

Feed	Birth to 26 wks	27-36 wks	37-48 wks	49-60 wks	61-62 wks	73-84 wks	85-96 wks	97-108 wks	Birth to 108 wks
Large Breeds									
Milk (lbs.)	450								450
Grain (lbs.)	410	181	226	238	259	279	339	333	2265
Hay (lbs.)	850	538	699	728	840	947	1107	1138	6787
Silage (lbs.)	0	525	612	686	769	939	989	1041	5420
Small Breeds									
Milk (lbs.)	300								300
Grain (lbs.)	290	127	179	240	252	284	304	327	2053
Hay (lbs.)	600	337	607	738	802	864	979	928	5695
Silage (lbs.)	0	343	536	681	754	851	828	913	4906

OARDC Research Circular 67, May 1959, and OARDC Research Bulletin 918, 1962

Feed Costs to 25 Months

In calculating feed costs, 15 percent was added to the hay cost to allow for cost of refusal. Data does not include costs beyond the 25-month period; however, for heifers that calve beyond this period, add approximately $11 per month for the large breeds and $10 per month for the small breeds. If heifers are on good pasture during any 12-week interval beyond 6 months of age during the 24-month period, the cost figures in Table 22 allow for substitution of pasture costs. Three dollars a month may be used for pasture costs.

Feed costs are based upon the following prices per 100 pounds: Milk-$5; grain-$3; hay-$175 from birth to 26 weeks and $1.25 from 27 to 108 weeks; and corn silage at 60 cents.

Using these prices, the feed costs for raising dairy replacemnts to 25 months of age may be found in Table 22.

Table 22: Estimated Feed Cost to 25 Months (Ohio Data)

Age Period	Large Breeds	Small Breeds
Birth to 26 weeks	$ 49.70	$ 34.20
27-36 weeks	16.38	10.74
37-48 weeks	20.50	17.33
49-60 weeks	21.74	21.91
61-72 weeks	24.40	23.63
73-84 weeks	27.03	26.07
85-96 weeks	32.04	28.19
97-108 weeks	32.63	28.65
Total	$224.42	$190.72

OARDC Research Circular 67, May 1959, and OARDC Research Bulletin 918, 1962

By substituting pasture for at least two 12-week (6 months) barn feeding periods, feed costs per animal could be reduced from $10 to $15 or more per head.

Table 23 lists estimated costs of raising dairy herd replacements from birth to 25 months.

Table 23: Estimated Costs to 25 Months
(Dry Lot Conditions)

Item	Large Breeds Dollars	Large Breeds Percent	Small Breeds Dollars	Small Breeds Percent
Feed	224.42	58.6	190.72	58.5
Labor (40 hrs.)	80.00	20.9 (35 hrs.)	70.00	21.4
Building Use	12.65	3.3	9.50	2.9
Interest on Investment	18.24	4.8	15.52	4.8
Miscellaneous	14.50	3.8	14.50	4.4
Bedding (1¾ T)	26.25	6.8 (1¼ T)	18.75	5.9
Breeding	7.00	1.8	7.00	2.1
Total Cost	383.06	100.0	325.99	100.0
Value Manure (8 T) @ $3.00/ton	24.00	(6 T)	18.00	
Value of Calf	30.00		20.00	
Net Cost	$329.06		$287.99	

OARDC Research Circular 67 and Cost Data from Department of Agricultural Economics, The Ohio State University

The estimated costs, as enumerated in Table 23, are based upon year-round dry lot feeding and growing of heifers in such a manner that they can be safely bred to calve at 24 months or slightly younger.

Workers at OARDC initiated a project in 1961 to determine the limitation of early breeding as another effort to lower costs of raising dairy herd replacements. Six Holstein and 6 Jersey heifers were bred artificially as soon as heat was first detected. A similar number of controls were bred according to the usual practice in the herd. The early bred Holsteins had produced 8,510 pounds of milk worth $340.40 by the time the controls calved at 27 months of age. The early bred Jerseys had produced 3,736 pounds of milk worth $186.80 by the time the controls calved at 24.5 months of age. These results indicate that ultimately earlier breeding can lower costs by shortening the "boarding" period.

The main disadvantage observed was the problem of difficult calving. One Holstein calf was dead at birth and 4 of the 6 Jerseys died during calving. In each case, all were males and were the larger calves.

An effort is being made through experiments in progress to reduce the size of the calf at birth by regulating the nutrition of the dam during late gestation. Until definite recommendations can be made on early breeding, it appears that dairymen should strive to grow heifers so they can be bred to calve at approximately 24 months of age.

Should Dairymen Buy or Raise Replacement?

As the trend continues toward greater specialization in the dairy industry, many Ohio dairymen are probably asking themselves the question, "Does it pay to raise replacements?" Today most dairy herd replacements in Ohio are home grown; however, some are being imported from other states and Canada, and a few are being raised under contract.

Dairymen who have limited resources in land, buildings and labor but rather extensive investments in milking equipment including parlors, pipeline

milkers, and bulk tanks may prefer further herd expansion as one means of reducing overhead costs. Dairy economists have estimated a 25 percent or more increase in cow numbers may be possible with the same production equipment, land, and other resources if the dairymen were relieved of raising replacements.

For many years, the assumption has been that raising all replacements was better than buying them. Some of the arguments presented were that purchased replacements are likely to be inferior in productive ability and disease could be more of a risk. Related to these characteristics, workers in New Hampshire, in recent years, indicated that little difference existed between raised and purchased replacments. These workers also found that home raised replacements were not necessarily the cheapest nor the most profitable. They pointed out that conditions on each farm need to be considered individually when deciding whether to buy or raise replacements.

Many Ohio diarymen have developed superior herds by following good breeding, feeding, and management programs. Perhaps these dairymen would not want to rely on random purchase of replacements. For them an alternative to buying or raising their own replacements would be a contract agreement with a dairyman who might want to specialize in raising dairy replacements. Farmers in many areas have buildings, pastures, and other farm resources suitable for raising heifers.

Few dairymen realize the true costs of raising dairy calves and heifers, largely because of the limited amount of data available. Our agricultural economists have cautioned that the real costs of raising herd replacements are more than those costs enumerated earlier in this publication and that they should also consider whether or not money invested in dairy replacements might produce higher returns if used in some other manner. For example, some dairymen may be further ahead to concentrate on the milking herd and either buy replacements or contract with someone else to raise them.

Contract Heifer Raising

Dairymen with limited facilities who wish to expand their milking operation could do so by having their replacements grown under contract. Contracts could be those with an option-to-purchase or direct contracts. Contracts should be equitable to both the dairymen and the growers and flexible enough to accommodate cost changes and desires of the parties involved.

Advantages of Contract Heifer Raising

A number of advantages which could be listed for both the dairyman and the replacement grower are as follows:

Dairyman

1. The possibility of expanding herd size 25 percent or more with the same facilities
2. Opportunity to specialize in milking cows
3. Money released for other investments
4. Can continue present breeding program
5. Labor, land, etc. released for expanding the milking herd
6. May reduce costs of replacements if dairyman is not a good calf raiser, or if present facilities are inadequate

Grower

1. Could use facilities that are inadequate for production of Grade A milk
2. Could provide part-time employment for semi-retired individual or someone who works off the farm
3. Provide employment for person with some physical disability but who could handle chores associated with this enterprise
4. May not like to milk cows but likes to work with calves and heifers
5. A way to gradually ease out of dairying
6. Could utilize grain to good advantage when farm located away from high-priced land areas and forage

Disadvantages of Contract Heifer Raising

Some disadvantages associated with the enterprise are:

Dairyman

1. Increased risk of introducing disease into herd
2. Could have a shortage of needed replacements if grower is not a good calf raiser
3. Replacements may cost more if labor and other resources released aren't used in some other manner
4. Venture may not be worthwhile if dairyman or dairymen can't provide enough calves to grower
5. Grower fails to employ above average sanitation practices

Grower

1. Short supply of calves from dairymen could make it a losing proposition
2. May be difficult to obtain a steady supply of heifers
3. Calf losses may be high, resulting in little or no profit
4. Demands close supervision of chores and regular routine
5. Must employ above average sanitation practices

Drawing Up A Contract

Contracts may be either option-to-purchase (owner sells the calf but reserves the right to buy the springer that results at market price) or direct contracts (dairyman retains ownership and pays the grower a fee). Regardless of the type contract, it may be advisable for dairymen to keep their calves until they reach at least 3 months of age, since the

grower may not have an available supply of milk. This eliminates bucket feeding of milk or a milk replacer thus reducing some of the risk of scours and high death losses.

Contracts should protect both the dairyman and grower. Following are some items to consider in drawing up a contract agreement.

1. Length of contract term
2. Provision for termination
3. Method for arbitration of disputes
4. Whether heifers are to be sold to grower with option-to-purchase or whether dairyman retains ownership and pays a fee to grower
5. Health requirements—calfhood vaccination, etc.
6. Who assumes the necessary veterinary costs
7. Who is responsible for transportation to and from the grower
8. Who assumes responsibility for breeding the heifers and cost of breeding
9. How are losses to be handled
10. Animal description sheet and Bill of Sale (option-to-purchase contract)

It is recommended that contracts be drawn up on a year to year to year basis. This provides for flexibility in establishing fees and other cost figures that parallel the general farm economy. Contracts should be written to permit both the addition and subtraction of animals as conditions dictate.

For option-to-purchase contracts, dairymen sell heifer calves to the grower at market price and reserve the right to purchase them back as springers at current market value. In direct contract agreements, the dairymen retain ownership of the animals and pay the grower a fee for raising the heifers to near the time of calving. Fees charged are generally on a monthly basis or so much per pound of gain.

DIRECT CONTRACT FOR RAISING REPLACEMENTS

_____County

_____Dairyman _____Grower

Clause I: **Parties Involved:** This contract is entered into this_____day of_____ 19____,

between _____ the grower, of _____ County of

_____, State of _____; and _____

the dairyman of _____, County of _____

State of _____.

Clause II: **Term of Contract:** The term of this contract shall be from the _____

_____ day of _____, 19____, to the _____ day of _____, 19____, and shall be automatically renewed from year to year unless otherwise terminated in accordance with the provisions herein or amended in writing as mutually agreed upon.

The following may be used as a guide in drawing up a direct contract for raising heifers:

The dairyman agrees to furnish the grower with the heifer calves listed on the description sheet attached hereto and made a part hereof.

The dairyman agrees to assume all legal responsibility as owner of the animals listed on the attached Description Sheet and will not hold the Grower liable for injury or death losses to the animals, except those due to negligence on the part of the Grower.

Clause III. **Termination of Contract:**

This contract may be terminated at any time by mutual agreement in writing; or by at least three months written notice from either party prior to the annual renewal date.

The animals on hand will be finished out or disposed of by the written terms in the contract.

Clause IV: **Arbitration**

Any dispute arising under the terms of this contract may be referred by the parties hereto to an arbitrator, or if one person cannot be found who is acceptable to both parties, then each shall choose an arbitrator and the two so chosen shall select a third. The Majority decision of the arbitrator(s) shall be presented to both parties in writing. The arbitrator(s) shall have the power to make an award or determination on any issue which arises out of the contract and it shall be binding on both parties. The expenses of the arbitrator(s) shall be divided equally between the parties. Pending final decision of a dispute hereunder, the parties hereto shall proceed diligently with the performance of the contract.

Clause V: **The Grower**

The grower agrees to pick up the heifer calves at 3 months of age. These animals will be listed on the description sheet.

Clause VI: **Additional Animals**

Additional animals may be added to this contract and all conditions of the contract shall apply to the additions. Both parties shall initial entries and exits on the Description Sheet of all original and additional animals.

Clause VII: **Other Conditions:**

The **dairyman** further agrees to:

1. Pay for vaccination of all calves for Brucellosis at ages between 3 and 6 months.
2. Pay all registration costs and retain registration certificates when registered animals are involved.
3. Have the heifers bred at his expense by the following method: Artificial insemination at approximately 15 months of age or by size.
4. Bear the transportation expenses of moving the heifers from the grower's farm to the dairyman's farm.

All the other veterinarian costs other than those listed should be shared, equally by both parties.

The **Grower** further agrees to:

1. Bear transportation expenses of moving the heifers from the dairyman's farm to the grower's farm.
2. Follow method outlined by dairymen for breeding heifers.
3. Have heifers vaccinated for brucellosis between 3 and 6 months of age.
4. In case of death (of an animal listed on the Description Sheet) for any reason not covered by insurance, the grower will credit the dairyman with 40 percent of total fee paid by the dairyman on said animal. This clause is null and void if animal is not picked up by specified time.

The dairyman shall have the privilege of inspecting the growing animal at regular intervals convenient to both parties.

Clause VIII: **Pick Up of Heifers**

The dairyman shall pick up said animals at approximately two years of age or four weeks before freshening.

The date of pick-up will be established for both parties by using the birth date of the calf and monthly payment will be handled in this manner.

The animals will be paid for by the dairyman to the grower at the rate of $9.00 per head per month and the remaining $5.00 per head per month (or its equivalent) at the time the heifers are picked up by the dairyman, making a total of $14.00 per head per month. (The fee could be based upon rate of gain. Thirty cents per pound would closely approach the $14.00 per month charge).

Clause IX: **Non-Exercise of Option**

The dairyman may elect not to take home certain animals on the Description Sheet under the following conditions: (1) Heifers that will not freshen before 28 months of age, and heifers that are more than 100 pounds in weight under the growth standard for age and breed.

Clause X: **Sale of Heifers to Other Than the Dairyman**

Heifers that the dairyman elects not to purchase as set forth in Clause IX of this contract shall be disposed of by the grower. The difference in sale price of these heifers from the agreed purchase price set up in the terms of this contract, when less, shall be equally divided between the grower and the dairyman.

Witness the hand and seal of the undersigned parties this _____ day of _____ 19____.

_____ Grower

_____ Witness

_____ Dairyman

_____ Witness

Other items which the dairyman and grower may want to include in the contract are a prescribed method of feeding, more detail on health requirements and a clause regarding insurance of animals.

Animal Description Sheet

The description sheet which should be attached to and made a part of the contract should provide for recording the following information for each animal: (The following items could serve as column heading from left to right across the top of the sheet)

1. Initials of Grower and Dairyman
2. Date of entry
3. Weight at entry
4. Age at entry
5. Eartag number
6. Tatto number
7. Registration number
8. Date of exit
9. Weight on date of exit
10. Exit initials of grower and dairyman
11. Remarks

Reproduction and Replacement in Dairy Herds, A Distinctive Concept

Multiplication through reproduction is a critical factor with swine, sheep, and poultry producers and to some extent with beef-breeding herds.

Pigs per litter raised, the lamb crop annual percentage, and eggs per hen (or chicks hatched) are prime efficiency factors with such species. Percentage of calves born and raised in beef herds likewise is of prime economic importance.

While percent of calf drop (number of live calves born per 100 cows) is also important to dairymen, other considerations are distinctive to and equally critical in the dairy enterprise.

1. **Early freshening** reduces the time and expense for "outgo" in raising an animal to freshening. Obviously, there are limitations dictated by normal growth rates, attainment of near-mature size and productive capability.
2. **Frequency of freshening** governs not only the number of offspring produced in the productive life of a cow but affects the continuity and lifetime milk production.
3. **Season or timeliness** of each freshening is a critical factor for each cow in a dairy herd especially as it relates to all other cows' time of freshening and contributes to an orderly regular year-round flow of milk for market demands.
4. **Total number of heifer calves** raised per cow is important only to the extent that it permits some selection among heifers raised for replacement, or extra heifers which make herd expansion or sale of surplus cattle possible.

Essentially, "replacement" to a dairyman requires raising "one female for one female," each to become productive at or near the time when the dam outlives her optimum economic value.

Hopefully, the replacement will be as good or better than her dam. Modern application of genetics makes this possible.